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Memorandum**

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ARTICLES, PAPERS, AND PRESENTATIONS**

Compiled by Joyce E. Turner
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FOREWORD

In accordance with the NASA Space Act of 1958, the MSFC has provided for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

Since July 1, 1960, when the George C. Marshall Space Flight Center was organized, the reporting of scientific and engineering information has been considered a prime responsibility of the Center. Our credo has been that "research and development work is valuable, but only if its results can be communicated and made understandable to others."

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GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama

FY 1990 SCIENTIFIC AND TECHNICAL REPORTS,
ARTICLES, PAPERS, AND PRESENTATIONS

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TM-100382 December 1989
Main Propulsion System Test Requirements for
the Two-Engine Shuttle-C. E.E. Lynn and G.K.
Platt. Propulsion Laboratory. N90-14282

The Shuttle-C is an unmanned cargo-carrying derivative of the space shuttle with optional two or three space shuttle main engines (SSME's), whereas the shuttle has three SSME's. Design and operational differences between the Shuttle-C and shuttle were assessed to determine requirements for additional main propulsion system (MPS) verification testing. Also, reviews were made of the shuttle main propulsion test (MPT) program objectives and test results and shuttle flight experience.

It was concluded that, if significant MPS modifications are not made beyond those currently planned, then main propulsion system verification can be concluded with an on-pad propellant loading and countdown demonstration test plus a long duration on-pad flight readiness firing.

TM-100383 December 1989
Comparison of Two Computer Codes for Crack Growth Analysis—NASCRAC Versus NASA/FLAGRO. R. Stallworth, C.A. Meyers, and H.C. Stinson. Structures and Dynamics Laboratory. N90-25360

This report presents results from the comparison study of two computer codes for crack growth analysis—NASCRAC and NASA/FLAGRO. The two computer codes gave compatible conservative results when the part through crack analysis solutions were analyzed versus experimental test data. Results showed good correlation between the codes for the through crack at a lug solution. For the through crack at a lug solution, NASA/FLAGRO gave the most conservative results.

TM-100384 October 1989
FY 1989 Scientific and Technical Reports, Articles, Papers, and Presentations. Compiled by Joyce E. Turner. Administrative Operations Office. N90-19916

This document presents formal NASA technical reports, papers published in technical journals, and

presentations by MSFC personnel in FY 89. It also includes papers of MSFC contractors.

After being announced in STAR, all of the NASA series reports may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

The information in this report may be of value to the scientific and engineering community in determining what information has been published and what is available.

TM-100385 December 1989
Statistical Evaluation of Jet Propulsion Laboratory (JPL) Erosive Burning Tests on Polybutadiene-Acrylic Acid-Acrylonitrile Propellant (PBAN). C.L. Martin. Propulsion Laboratory. X90-10284

The JPL has completed a test program, using multisegment BATES and 5×10 -in batch-check motors, with the objectives of measuring the effects of the parameters that were considered to most strongly influence the transition to, or threshold conditions for, erosive burning rate augmentation. A statistical analysis was performed on the test data to explore the possible relationships among the parameters believed to influence the rate of erosive burning. Multivariate methods and simple and multiple regressions were used, and a model for predicting erosive burning rates in small PBAN circular perforated grains was developed.

TM-100386 July 1990
Atmospheric Environment for Space Shuttle (STS-28) Launch. G.L. Jasper and G.W. Batts. Space Science Laboratory. N90-25452

This report presents a summary of selected atmospheric conditions observed near Space Shuttle STS-28 launch time on August 8, 1989, at Kennedy Space Center, Florida. STS-28 carried a Department of Defense payload and the flight azimuth in this report will be denoted by a reference flight azimuth, since the actual flight azimuth is not known. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of prelaunch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-28

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vehicle ascent has been constructed and represents the best estimate of the launch environment to 400,000 ft altitude that was traversed by the STS-28 vehicle. The STS-28 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in post-flight performance assessments.

TM-100387 January 1990
Global Nonlinear Optimization of Spacecraft Protective Structures Design. R.A. Mog, J.N. Lovett, Jr., and S.L. Avans. Structures and Dynamics Laboratory. N90-21095

The global optimization of protective structural designs for spacecraft subject to hypervelocity meteoroid and space debris impacts is presented. This nonlinear problem is first formulated for weight minimization of the space station core module configuration using the Nysmith impact predictor. Next, the equivalence and uniqueness of local and global optima is shown using properties of convexity. This analysis results in a new feasibility condition for this problem. The solution existence is then shown, followed by a comparison of optimization techniques. Finally, a sensitivity analysis is presented to determine the effects of variations in the systemic parameters on optimal design. The results show that global optimization of this problem is unique and may be achieved by a number of methods, provided the feasibility condition is satisfied. Furthermore, module structural design thicknesses and weight increase with increasing projectile velocity and diameter and decrease with increasing separation between bumper and wall for the Nysmith predictor.

TM-100388 February 1990
PATRAN-STAGS Translator (PATSTAGS). Neil Otte. Structures and Dynamics Laboratory. N90-19616

This document presents a computer program used to translate PATRAN finite element model data into STAGS (Structural Analysis of General Shells) input data. The program supports translation of nodal, nodal constraints, element, force, and pressure data. The subroutine UPRESS required for the readings of live pressure data into STAGS is also presented.

TM-100389 February 1990
Feasibility of Using Extreme Ultraviolet (EUV) Reaction Wheels to Satisfy Space Infrared Telescope Facility (SIRTF) Maneuver Requirements. W.D. Lightsey. Preliminary Design Office. N90-19556

A digital computer simulation is used to determine if the extreme ultraviolet explorer (EUV) reaction wheels can provide sufficient torque and momentum storage capability to meet the space infrared telescope facility (SIRTF) maneuver requirements. A brief description of the pointing control system (PCS) and the sensor and actuator dynamic models used in the simulation is presented. A model to represent a disturbance such as fluid sloshing is developed. Results developed with the simulation, and a discussion of these results are presented.

TM-100390 March 1989
Rolling Contact Fatigue of Surface Modified 440C Using a "Ge-Polymer" Type Disc Rod Test Rig. R.L. Thom. Materials and Processes Laboratory. N90-20200

Through hardened 440C martensitic stainless steel test specimens were surface modified and tested for changes in rolling contact fatigue using a disc on rod test rig. The surface modifications consisted of nitrogen, boron, titanium, chromium, tantalum, carbon, or molybdenum, ion implantation at various ion fluences and energies. Tests were also performed on specimens reactively sputtered with titanium nitride.

TM-100391 February 1990
Cross-Sectional Examination of the Damage Zone in Impacted Specimens of Carbon/Epoxy and Carbon/PEEK Composites. A.T. Nettles and N.J. Magold. Materials and Processes Laboratory. N90-21125

Drop weight impact testing was utilized to inflict damage on eight-ply bidirectional and unidirectional samples of carbon/epoxy and carbon/PEEK (polyetheretherketone) test specimens with impact energies ranging from 0.80 J to 1.76 J. The impacting tup was of a smaller diameter (4.2-mm) than those used in most previous studies, and the specimens were placed over a hole 10.3 mm in diameter to obtain a puncture

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The corrosion protection of 6061-T6 anodized aluminum afforded by a newly patented polyurethane seal has been studied using the ac impedance technique. Values of the average corrosion rates over a 27-day exposure period in 3.5% NaCl solutions at pH 5.2 and pH 9.5 compared very favorably for Lockheed-prepared polyurethane-sealed and dichromate-sealed coats of the same thickness. Average corrosion rates for both specimens over the first 7 days of exposure compared well with those for a hard anodized, dichromate-sealed coat, but rose well above those for the hard anodized coat over the entire 27-day period. This is attributed both to the greater thickness of the hard anodized coat, and possibly to its inherently better corrosion protective capability.

TM-100395 April 1990
Definition of Large Components Assembled On-Orbit and Robot Compatible Mechanical Joints. J. Williamsen, F. Thomas, J. Finckenor, and B. Spiegel. Structures and Dynamics Laboratory.
N90-22043

One of four major areas of project Pathfinder is in-space assembly and construction. The task of in-space assembly and construction is to develop the requirements and the technology needed to build elements in space.

This paper identifies a 120-ft diameter tetrahedral aerobrake truss as the focus element. A heavily loaded mechanical joint is designed to robotically assemble the defined aerobrake element. Also, typical large components such as habitation modules, storage tanks, etc., are defined, and attachment concepts of these components to the tetrahedral truss are developed.

TM-100396 December 1989
Atmospheric Environment for Space Shuttle (STS-34) Launch. G.L. Jasper and G.W. Batts. Space Science Laboratory.

This report presents a summary of selected atmospheric conditions observed near space shuttle STS-34 launch time on October 18, 1989, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters

versus altitude, for STS-34 vehicle ascent has been constructed. The STS-34 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in post-flight performance assessments and represents the best estimate of the launch environment to the 400,000-ft altitude that was traversed by the STS-34 vehicle.

TM-100397 April 1990
The Temperature Variation of Hydrogen Diffusion Coefficients in Metal Alloys. M.D. Danford. Materials and Processes Laboratory.
N90-21836

Hydrogen diffusion coefficients have been measured as a function of temperature for a few metal alloys using an electrochemical evolution technique. Results from these measurements are compared to those obtained by the time-lag method. In all cases, diffusion coefficients obtained by the electrochemical method are larger than those by the time-lag method by an order of magnitude or more. These differences are attributed mainly to hydrogen trapping.

TM-100398 April 1990
Gamma-Ray Bursts: Current Status of Observations and Theory. C.A. Meegan. Space Science Laboratory.
N90-22526

Gamma-ray bursts display a wide range of temporal and spectral characteristics, but typically last several seconds and emit most of their energy in the low-energy, gamma-ray region. The burst sources appear to be isotropically distributed on the sky. Several lines of evidence suggest magnetic neutron stars as sources for bursts. A variety of energy sources and emission mechanisms have been proposed.

TM-100399 March 1990
Atmospheric Environment for Space Shuttle (STS-33) Launch. G.J. Jasper and G.W. Batts. Space Science Laboratory.
N90-28159

This report presents a summary of selected atmospheric conditions observed near space shuttle STS-33 launch time on November 22, 1989, at Kennedy Space Center, Florida. STS-33 carried a Department of Defense payload and the flight azimuth in this report will be denoted by a reference flight azimuth, since the

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actual flight azimuth is not known. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-33 vehicle ascent has been constructed. The STS-33 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in postflight performance assessments and represents the best estimate of the launch environment to the 400,000-ft altitude that was traversed by the STS-33 vehicle.

TM-100400 March 1990
Atmospheric Environment for Space Shuttle (STS-32) Launch. G.L. Jasper and G.W. Batts. Space Science Laboratory.

This report presents a summary of selected atmospheric conditions observed near space shuttle STS-32 launch time on January 9, 1990, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-32 vehicle ascent has been constructed. The STS-32 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in postflight performance assessments and represents the best estimate of the launch environment that was traversed by the STS-32 vehicle.

TM-100401 June 1990
Estimating the Cost of Major Ongoing Cost Plus Hardware Development Programs. J.C. Bush. Space Systems Project Office. N90-25705

This memorandum develops approaches for forecasting the cost of major hardware development programs while these programs are in the design and development C/D phase. Three approaches are developed: a schedule assessment technique for bottom-line summary cost estimation, a detailed cost

estimation approach, and an intermediate cost element analysis procedure. The schedule assessment technique was developed using historical cost/schedule performance data.

TM-100402 June 1990
Equivalent Circuit Models for AC Impedance Data Analysis. M.D. Danford. Materials and Processes Laboratory. N90-25277

A least-squares fitting routine has been developed for the analysis of ac impedance data. It has been determined that the checking of the derived equations for a particular circuit with a commercially available electronics circuit program is essential. As a result of the investigation described in this report, three equivalent circuit models have been selected for use in the analysis of ac impedance data at this laboratory.

TM-100403 May 1990
Atmospheric Environment for Space Shuttle (STS-36) Launch. G.L. Jasper and G.W. Batts. Space Science Laboratory.

This report presents a summary of selected atmospheric conditions observed near space shuttle STS-36 launch time on February 28, 1990, at Kennedy Space Center, Florida. STS-36 carried a Department of Defense payload, and the flight azimuth in this report will be denoted by a reference flight azimuth, since the actual flight azimuth is not known. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-36 vehicle ascent has been constructed. The STS-36 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in postflight performance assessments and represents the best estimate of the launch environment to the 400,000-ft altitude that was traversed by the STS-36 vehicle.

TM-100404 June 1990
NASA Marshall Space Flight Center Solar Observatory Report—January–December 1989.

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J.E. Smith. Space Science Laboratory.

N90-25923

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during January–December 1989. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code. The data are represented by longitudinal contours with azimuth plots.

TM-100405

July 1990

The Charged Particle Radiation Environment for AXAF. Marshall Joy. Space Science Laboratory.

N90-26741

The Advanced X-Ray Astrophysics Facility (AXAF) will be subject to several sources of charged particle radiation during its 15-year orbital lifetime: geomagnetically-trapped electrons and protons, galactic cosmic ray particles, and solar flare events. The purpose of this report is to estimate these radiation levels for the AXAF orbit for use in the design of the observatory's science instruments.

TM-103505

August 1990

A Transient Response Analysis of the Space Shuttle Vehicle During Liftoff. J.A. Brunty. Structures and Dynamics Laboratory.

N90-27735

A proposed transient response method is formulated for the liftoff analysis of the space shuttle vehicle. The proposed method uses a power series approximation with unknown coefficients for the interface forces between the space shuttle and mobile launch platform. This allows the equations of motion of the two structures to be solved separately with unknown coefficients at the end of each time step. The unknown coefficients are obtained by enforcing the interface compatibility conditions between the two structures. Once the unknown coefficients are determined, the total response is computed for that time step. The method is validated by a numerical example of a cantilevered beam and by the liftoff analysis of the space shuttle vehicle. The proposed method is compared to an iterative transient response analysis method used by Martin Marietta for their space shuttle liftoff analysis. It is shown that the proposed method uses less

computer time than the iterative method and does not require as small a time step for integration. The space shuttle vehicle model is reduced using two different types of component mode synthesis (CMS) methods, the Lanczos CMS method and the Craig and Bampton CMS method. By varying the cutoff frequency of the Craig and Bampton method it was shown that the space shuttle interface loads can be computed with reasonable accuracy. Both the Lanczos CMS method and Craig and Bampton CMS method give similar results. A substantial amount of computer time is saved using the Lanczos CMS method over that of the Craig and Bampton method. However, when trying to compute a large number of Lanczos vectors, input/output computer time increased and increased the overall computer time. The application of several liftoff release mechanisms that can be adapted to the proposed method are discussed.

TM-103506

August 1990

Hubble Space Telescope Six-Battery Test Bed. J.A. Pajak, J.R. Bush, Jr., and J.R. Lanier, Jr. Information and Electronic Systems Laboratory.

N90-27731

A test bed for a large space power system breadboard for the Hubble Space Telescope (HST) was designed and built to test the system under simulated orbital conditions. A discussion of the data acquisition and control subsystems designed to provide for continuous 24-hour per day operation and a general overview of the test bed is presented. The data acquisition and control subsystems provided the necessary monitoring and protection to assure safe shutdown with protection of test articles in case of loss of power or equipment failure over the life of the test (up to 5 years).

TM-103507

July 1990

Analysis Techniques for Residual Acceleration Data. M.J.B. Rogers, J.I.D. Alexander, and R.S. Snyder. Space Science Laboratory.

Various aspects of residual acceleration data are of interest to low-gravity experimenters. Maximum and mean values and various other statistics can be obtained from data as collected in the time domain. Additional information may be obtained through manipulation of the data. Fourier analysis is discussed as a means of obtaining information about dominant

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frequency components of a given data window. Transformation of data into different coordinate axes is useful in the analysis of experiments with different orientations and can be achieved by the use of a transformation matrix. Application of such analysis techniques to residual acceleration data provides additional information than what is provided in a time history and increases the effectiveness of post-flight analysis of low-gravity experiments.

TM-103508 June 1990
Atmospheric Environment for Space Shuttle (STS-31) Launch. G.L. Jasper and G.W. Batts. Space Science Laboratory.

This report presents a summary of selected atmospheric conditions observed near space shuttle STS-31 launch time on April 24, 1990, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-31 vehicle ascent has been constructed. The STS-31 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in postflight performance assessments and represents the best estimate of the launch environment to the 400,000-ft altitude that was traversed by the STS-31 vehicle.

TM-103509 July 1990
TRANSTRAIN: A Program to Compute Strain Transformations in Composite Materials. Rafiq Ahmed. Structures and Dynamics Laboratory.
N90-27877

This report documents a computer program that generates strain transformations and on-axis stresses in composites given the initial strains and the transformation angles.

TM-103511 August 1990
Reliability Growth Modeling Analysis of the Space Shuttle Main Engines Based Upon the Weibull Process. J.T. Wheeler. Structures and Dynamics Laboratory.
N90-28098

The Weibull process, identified as the non-homogeneous Poisson process with the Weibull intensity function, is used to model the reliability growth assessment of the space shuttle main engine test and flight failure data. Additional tables of percentage-point probabilities for several different values of the confidence coefficient have been generated for setting $(1-\alpha)100$ -percent two-sided confidence interval estimates on the mean time between failures. The tabled data pertain to two cases: (1) time-terminated testing and (2) failure-terminated testing. The critical values of the three test statistics, namely Cramér-von Mises, Kolmogorov-Smirnov, and chi-square, have been calculated and tabled for use in the goodness-of-fit tests for the engine reliability data. Numerical results are presented for five different groupings of the engine data that reflect the actual responses to the failures.

TM-103512 August 1990
NASA Marshall Space Flight Center Solar Observatory Report—January–June 1990. J.E. Smith. Space Science Laboratory.

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during January–June 1990. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code. The data are represented by longitudinal contours with azimuth plots.

TM-103513 July 1990
Mesoscale Lightning Experiment (MLE): A View of Lightning as Seen From Space During the STS-26 Mission. O.H. Vaughan, Jr. Space Science Laboratory.

This report provides information on the data obtained from the Mesoscale Lightning Experiment (MLE) flown on STS-26. The experiment used on-board TV cameras and a 35-mm film camera to obtain data. Data from the 35-mm film camera are presented. During the mission, the crew had difficulty locating the various targets of opportunity with the TV cameras. To obtain as much data as possible in the short observational timeline allowed due to other commitments, the crew opted to use the hand-held 35-mm camera.

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TM-4168 January 1990
New Atmospheric Turbulence Model for Shuttle Applications. C.G. Justus, C.W. Campbell, M.K. Doubleday, and D.L. Johnson. Space Science Laboratory. N90-16389

This report presents an updated NASA atmospheric turbulence model, from 0- to 200-km altitude, which was developed to be more realistic and less conservative when applied to space shuttle reentry engineering simulation studies involving control system fuel expenditures. The prior model used extreme turbulence (3σ) for all altitudes, whereas in reality severe turbulence is patchy within quiescent atmospheric zones. The updated turbulence model presented in this report is designed to be more realistic. The prior turbulence statistics (σ and L) have been updated and have been modeled accordingly.

TM-4172 January 1990
A Field Study of Solid Rocket Exhaust Impacts on the Near-Field Environment. B.J. Anderson and V.W. Keller. Space Science Laboratory. N90-18102

Large solid rocket motors release large quantities of hydrogen chloride and aluminum oxide exhaust during launch or testing. This report summarizes measurements and analysis of the interaction of this material with the deluge water spray and other environmental factors in the near field (within 1 km of the launch or test site). Measurements of mixed solid and liquid deposition (typically 2 normal HCl) following space shuttle launches and 6.4 percent scale model tests are described. Hydrogen chloride gas concentrations measured in the hours after the launch of STS 41D and STS 51A are reported. Concentrations of 9 ppm, which are above the 5 ppm exposure limits for workers, were detected an hour after STS 51A. A simplified model which explains the primary features of the gas concentration profiles is included.

TM-4204 May 1990
Space Station *Freedom* Environmental Control and Life Support System Phase III Simplified Integrated Test Detailed Report. B.C. Roberts, R.L. Carrasquillo, M.Y. DuBiel, K.Y. Ogle, J.L. Perry, and K.M. Whitley. Structures and Dynamics Laboratory. N90-22593

This report is a description of the phase III simplified integrated test (SIT) conducted at the Marshall Space Flight Center (MSFC) Core Module Integration Facility (CMIF) in 1989. This was the first test in the phase III series integrated environmental control and life support systems (ECLSS) tests. The basic goal of the SIT was to achieve full integration of the baseline air revitalization (AR) subsystems for Space Station *Freedom*. Included in this report is a description of the SIT configuration, a performance analysis of each subsystem, results from air and water sampling, and a discussion of lessons learned from the test. Also included in this report is a full description of the preprototype ECLSS hardware used in the test.

TM-4206 June 1990
Geometric Programming Prediction of Design Trends for OMV Protective Structures. R.A. Mog and J.R. Horn. Structures and Dynamics Laboratory. N90-23462

The global optimization trends of protective honeycomb structural designs for spacecraft subject to hypervelocity meteoroid and space debris impacts are presented. This nonlinear problem is first formulated for weight minimization of the orbital maneuvering vehicle (OMV) using a generic monomial predictor. Five problem formulations are considered, each dependent on the selection of independent design variables. Each case is optimized by considering the dual geometric programming problem. The dual variables are solved for in terms of the generic estimated exponents of the monomial predictor. The primal variables are then solved for by conversion. Finally, parametric design trends are developed for ranges of the estimated regression parameters. Results specify nonmonotonic relationships for the optimal first and second sheet mass per unit areas in terms of the estimated exponents.

TM-4233 September 1990
Minimum Weight Design of a Leaf Spring Tapered in Thickness and Width for the Hubble Space Telescope-Space Support Equipment. P.I. Rodriguez. Structures and Dynamics Laboratory. X90-36120

A linear elastic solution to the problem of minimum weight design of cantilever beams with variable width and depth is presented. The solution shown

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is for the specific application of the Hubble Space Telescope maintenance mission hardware. During these maintenance missions, delicate instruments must be isolated from the potentially damaging vibration environment of the space shuttle cargo bay during the ascent and descent phases. The leaf springs are designed to maintain the isolation system natural frequency at a level where load transmission to the instruments is a minimum.

Nonlinear programming is used for the optimization process. The weight of the beams is the objective function with the deflection and allowable bending stress as the constraint equations. The design variables are the width and depth of the beams at both the free and the fixed ends.

TM-4202

October 1990

Space Station *Freedom* Environmental Control and Life Support System (ECLSS) Phase III Simplified Integrated Test Trace Contaminant Control Subsystem Performance. J.L. Perry, Structures and Dynamics Laboratory.

Space Station *Freedom* environmental control and life support system testing has been conducted at Marshall Space Flight Center since 1986. The phase III simplified integrated test (SIT) conducted from July 30, 1989, through August 11, 1989, tested an integrated air revitalization system. During this test, the trace contaminant control subsystem (TCCS) was directly integrated with the bleed stream from the carbon dioxide reduction subsystem. The TCCS performed as expected with minor anomalies. The test set the basis for further characterizing the TCCS performance as part of advance air revitalization system configurations.

NASA TECHNICAL PAPERS

TP-2926 December 1989
A Transient Response Method for Linear Coupled Substructures. J.R. Admire and J.A. Brunty. Structures and Dynamics Laboratory. N90-13444

This paper presents a new method for determining the transient response of a discrete coordinate model of a linear structural system composed of substructures. The method is applicable to systems consisting of any number of substructures, both determinate and indeterminate interface boundaries, and any topological arrangement of the substructures. The method is simple to implement from a computational point of view because the equations of motion of each of the substructures are solved independently, and the interface boundary compatibility conditions are enforced at each integration time step by a matrix multiplication. The method is demonstrated for a structural system consisting of two beam segments and acted upon by a time dependent force. The numerical results from the demonstration problem validates the accuracy of the method. The application of this method to structural systems with changing interface boundary conditions between substructures is discussed.

TP-2948 October 1989
On the Statistics of El Niño Occurrences and the Relationship of El Niño to Volcanic and Solar/Geomagnetic Activity. R.M. Wilson. Space Science Laboratory. N90-12456

El Niño is conventionally defined as an anomalous and persistent warming of the waters off the coasts of Ecuador and Peru in the eastern equatorial Pacific, having onset usually in southern hemispheric summer/fall. Examined here are some of the statistical aspects of El Niño occurrences, especially as they relate to the normal distribution and to possible associations with volcanic, solar, and geomagnetic activity.

With regard to the "very strong" El Niño of 1982-83, it is noted that, although it may very well be related to the 1982 eruptions of El Chichón, the event occurred essentially "on time" (with respect to the past behavior of elapsed times between successive El Niño events; a moderate-to-stronger El Niño was expected during the interval 1978 to 1982, assuming that El Niño occurrences are normally distributed,

having a mean elapsed time between successive onsets of 4 years and a standard deviation of 2 years and a last known occurrence in 1976). Also, although not widely recognized, the whole of 1982 was a record year for geomagnetic activity (based on the aa geomagnetic index, with the aa index registering an all-time high in February 1982), perhaps, important for determining a possible "trigger" for this and other El Niño events.

A major feature of this study is an extensive bibliography (325 entries) on El Niño and volcanic-solar-geomagnetic effects on climate. Also, included is a tabular listing of the 94 major volcanic eruptions of 1835 to 1986.

TP-2976 January 1990
Payload Crew Utilization for Spacelab Missions. K.Y. Ibrahim and J.D. Weiler. Systems Analysis and Integration Laboratory. N90-14256

This study analyzed planned payload crew utilization on Spacelab missions for the primary purpose of establishing trends and guidelines. The study included missions that have flown to date as well as those in planning. Available data were analyzed on the basis of four major timeline iterations that occur during mission design. Data were categorized and assessed by crewmember, flight day, and mission. Based on the results of this analysis it was recommended that for the Requirements Review (RR) and Preliminary Design Review (PDR) iterations the maximum utilization per shift should be 75 percent for the Payload Specialist (PS) and 65 percent for the Mission Specialist (MS); and for the basic and final iterations, the maximum utilization per shift should be 85 percent for the PS and 75 percent for the MS. Additional recommendations include limiting the amount of activity during the first two shifts whenever possible and establishing a common set of guidelines for the calculation of crew utilization.

TP-2981 January 1990
Instrumented Impact and Residual Tensile Strength Testing of Eight-Ply Carbon/Epoxy Specimens. A.T. Nettles. Materials and Processes Laboratory. N90-16007

Instrumented drop weight impact testing was utilized to examine a puncture-type impact on thin

carbon/epoxy coupons. Four different material systems with various eight-ply lay-up configurations were tested. Specimens were placed over a 10.3-mm diameter hole and impacted with a smaller tup (4.2-mm diameter) than those used in previous studies. Force-time plots as well as data on absorbed energy and residual tensile strength were gathered and examined. It was found that a critical impact energy level existed for each material tested, at which point tensile strength began to rapidly decrease with increasing impact energy.

TP-3013 May 1990
 A General-Purpose Balloon-Borne Pointing System for Solar Scientific Instruments. M.E. Polites. Structures and Dynamics Laboratory. N90-21219

This paper describes a general-purpose balloon-borne pointing system for accommodating a wide variety of solar scientific instruments. It is designed for precise pointing, low cost, and quick launch. It offers the option of three-axis control, pitch-yaw-roll, or two-axis control, pitch-yaw, depending on the needs of the solar instrument. Simulation results are presented that indicate good pointing capability at Sun elevation angles ranging from 10 degrees to 80 degrees.

TP-3023 June 1990
 Mode-Medium Instability and Its Correction With a Gaussian Reflectivity Mirror. K.L. Webster and C.C. Sung. Information and Electronic Systems Laboratory. N90-25673

A high power CO₂ laser beam is known to deteriorate after a few microseconds due to a mode-medium instability (MMI) which results from an intensity dependent heating rate related to the vibrational-to-translational decay of the upper and lower CO₂ lasing levels. An iterative numerical technique is developed to model the time evolution of the beam as it is affected by the MMI. The technique is used to study the MMI in an unstable CO₂ resonator with a hard-edge output mirror for different parameters like the Fresnel number and the gas density. The results show that the mode of the hard-edge unstable resonator deteriorates because of the diffraction ripples in the mode. We use a Gaussian-reflectivity mirror to correct the MMI. This mirror produces a smoother

intensity profile which significantly reduces the effects of the MMI. Quantitative results on peak density variation and beam quality are presented.

TP-3028 June 1990
 Loads Analysis and Testing of Flight Configuration Solid Rocket Motor Outer Boot Ring Segments. Rafiq Ahmed. Structures and Dynamics Laboratory. N90-25366

This report details the loads testing on in-house-fabricated flight configuration SRM outer boot ring segments. The tests determined the bending strength and bending stiffness of these beams and showed that they compared well with the hand analysis. The bending stiffness test results compared very well with the finite element data.

TP-3029 July 1990
 Low Velocity Instrumented Impact Testing of Four New Damage Tolerant Carbon/Epoxy Composite Systems. D.G. Lance and A.T. Nettles. Materials and Processes Laboratory. N90-25198

Low velocity drop weight instrumented impact testing was utilized to examine the damage resistance of four recently developed carbon fiber/epoxy resin systems. A fifth material, T300/934, for which a large data base exists, was also tested for comparison purposes. A 16-ply quasi-isotropic lay-up configuration was used for all the specimens. Force/absorbed energy-time plots were generated for each impact test. The specimens were cross-sectionally analyzed to record the damage corresponding to each impact energy level. Maximum force of impact versus impact energy plots were constructed to compare the various systems for impact damage resistance. Results show that the four new damage tolerant fiber/resin systems far outclassed the T300/934 material. The most damage tolerant material tested was the IM7/1962 fiber/resin system.

TP-3030 June 1990
 Rotating-Unbalanced-Mass Devices for Scanning Balloon-Borne Experiments, Free-Flying Spacecraft, and Space Shuttle/Space Station Experiments. M.E. Polites. Structures and Dynamics Laboratory. N90-25255

NASA TECHNICAL PAPERS

This paper presents a new method for scanning balloon-borne experiments, free-flying spacecraft, and gimballed experiments mounted to the space shuttle or the space station. It uses rotating-unbalanced-mass (RUM) devices for generating circular, line, or raster scan patterns and an auxiliary control system for target acquisition, keeping the scan centered on the target, and producing complementary motion for raster scanning. It is ideal for applications where the only possible way to accomplish the required scan is to physically scan the entire experiment or spacecraft as in x-ray and gamma-ray experiments. In such cases, this new method should have advantages over prior methods in terms of either power, weight, cost, performance, stability, or a combination of these.

TP-3031 July 1990
Forbidden Tangential Orbit Transfers Between
Intersecting Keplerian Orbits. R.E. Burns. Sys-
tems Analysis and Integration Laboratory.
N90-26028

The classical problem of tangential impulse transfer between coplanar Keplerian orbits is addressed. A completely analytic solution which does not rely on sequential calculation is obtained and this solution is used to demonstrate that certain initially chosen angles can produce singularities in the parameters of the transfer orbit. A necessary and sufficient condition for such singularities is that the initial and final orbits intersect.

TP-3042 August 1990
An Examination of Impact Damage in Glass/
Phenolic and Aluminum Honeycomb Core
Composite Panels. A.T. Nettles, D.G. Lance,
and A.J. Hodge. Materials and Processes Labor-
atory. N90-27876

An examination of low velocity impact damage to glass/phenolic and aluminum core honeycomb sandwich panels with carbon/epoxy facesheets is presented. An instrumented drop weight impact test apparatus was utilized to inflict damage at energy ranges between 0.7 and 4.2 Joules. Specimens were checked for extent of damage by cross-sectional examination. The effect of core damage was assessed by subjecting impact-damaged beams to four-point bend tests. Skin-only specimens (facings not bonded to honeycomb) were also tested for comparison purposes. Results show that core buckling is the first damage mode, followed by delaminations in the facings, matrix cracking, and finally fiber breakage. The aluminum honeycomb panels exhibited a larger core damage zone and more facing delaminations than the glass/phenolic core, but could withstand more shear stress when damaged than the glass/phenolic core specimens.

TP-3058 August 1990
Long-Term Orbital Lifetime Predictions. P.E.
Dreher and A.T. Lyons. Missions Operations
Laboratory.

This study analyzed long-term orbital lifetime predictions. Predictions were made for three satellites: the Solar Max Mission (SMM), the Long Duration Exposure Facility (LDEF), and the Pegasus Boiler Plate (BP). A technique is discussed for determining an appropriate ballistic coefficient to use in the lifetime prediction. The orbital decay rate should be monitored regularly. Ballistic coefficient updates should be done whenever there is a significant change in the actual decay rate or in the solar activity prediction.

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FICHTL, G.H.</p> | <p>ES42</p> | <p>Growth of Bulk Single Crystals of Organic Materials for Nonlinear Optical Devices: An Overview. For publication in Progress in Crystal Growth and Characterization, Great Britain.</p> |
| <p>Analysis of Coolant Flow and Heat Transfer in the SSME HPOTP No. 4 Bearing Assembly. For publication in the AIAA Journal, San Diego, CA.</p> | | <p>PETERS, P.N.
DECHER, R.
SISK, R.C.</p> |
| | <p>ES63</p> | <p>Self-Stable Suspended Rotors Utilizing Superconducting Niobium. For presentation at the 25th Intersociety Energy Conversion Engineering Conference – Magnetic Bearing Symposium, Reno, NV, August 12–17, 1990.</p> |
| <p>OWENS, S.
COSTES, N.</p> | <p>ES42</p> | |
| <p>Analysis of Coolant Flow and Heat Transfer in the SSME HPOTP Number 4 Bearing Assembly. For presentation at the AIAA 28th Aerospace Science Meeting, Reno, NV, January 8–11, 1990.</p> | | <p>PETERS, P.N.
GREGORY, J.C.</p> |
| | <p>ES63</p> | <p>Atomic Oxygen Effects on Films. For presentation at the AIAA Space Programs and Technologies Conference and Exhibit, Huntsville, AL, September 25–27, 1990.</p> |
| <p>OYEDIRAN, A.A.
RICHMAN, M.W.
COSTES, N.C.</p> | <p>ES42</p> | |
| <p>Numerical Solutions to the Flow of Granular Materials Down Bumpy Inclines. For presentation at the 42nd Annual Meeting of Division of Fluid Dynamics of American Physics Society, NASA/Ames Research Center, November 19–31, 1989.</p> | | <p>PIZZANO, F.</p> |
| | | <p>CT11</p> |
| | | <p>Criticality Assessment Approach for Space Station Project. For presentation at the Probabilistic Safety Assessment and Management (PSAM), Beverly Hills, CA, February 4–7, 1991.</p> |
| <p>PARNELL, T.A.
BURNETT, T.H.
DAKE, S.
DERRICKSON, J.H.
et al.</p> | <p>ES62</p> | |
| <p>Emulsion Chambers in Magnetic Fields for Heavy Cosmic Ray Interaction and Composition Studies. For presentation at the 21st International Cosmic Ray Conference, University of Adelaide, Adelaide, Australia, January 6–19, 1990.</p> | | <p>POLITES, M.E.</p> |
| | | <p>ED12</p> |
| | | <p>Scanning Balloon-Borne Experiments, Free-Flying Spacecraft, and Space-Based Experiments Using Rotating-Unbalanced-Mass Devices. For publication in the Journal of Guidance, Control, and Dynamics, Washington, DC.</p> |
| <p>PATTERSON, W.J.</p> | <p>EH33</p> | |
| <p>Shuttle Redesigned Solid Rocket Motor (RSRM) Joint Seal Materials. For presentation at the SAE Seals Committee A-6 Technical Meeting, Orlando, FL, May 6–12, 1990.</p> | | <p>POLLOCK, C.J.
CHANDLER, M.O.</p> |
| | | <p>ES53</p> |
| | | <p>A Survey of Upwelling Ion Event Characteristics. For publication in JGR, Washington, DC.</p> |
| <p>PENN, B.
CARDELINO, B.
MOORE, C.
SHIELDS, A.
FRAZIER, D.</p> | <p>ES74</p> | |
| | | <p>POLLOCK, C.J.
CHAPPELL, C.R.</p> |
| | | <p>ES53</p> |
| | | <p>Electrostatic Reflection of Ion Streams Near the Geomagnetic Equator. For presentation at the 1990 Spring Meeting of the American Geophysical Union, Baltimore, MD, May 29–June 1, 1990.</p> |
| | | <p>POLLOCK, C.J.
CHAPPELL, C.R.</p> |
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- HORWITZ, J.L.
WINNINGHAM, J.D. ES53
Two Spacecraft Observations Interpreted in Terms of Electrostatic Potential Drops Along Polar Cap Field Lines. For publication in the Proceedings of the Second Huntsville Workshop on Magnetosphere/Ionosphere Plasma Models, Washington, DC.
- POLLOCK, C.J. ES53
MARTINEZ, N.J.
MOORE, T.E.
SLOAN, M.A.
Development of a Thermal Electron Capped Hemisphere Spectrometer (TECHS) Through the Use of Extreme Miniaturization. For presentation at the 1990 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 3-7, 1990.
- POLLOCK, C.J. ES53
CHAPPELL, C.R.
Electrostatic Reflection of Ion Streams Near the Geomagnetic Equator. For presentation at the UAH Plasmasphere Refilling Workshop, Huntsville, AL, October 15-16, 1990.
- PORTER, J.G. ES52
MOORE, R.L.
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- PORTER, J.G. ES52
DERE, K.P.
The Magnetic Network Location of Explosive Events Observed in the Solar Transition Region. For publication in the Astrophysical Journal, Chicago, IL.
- PORTER, L.Z. ES01
DeMAR, P. Fermi National Laboratory
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- POWERS, W.T. EB22
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- POWERS, W.T. EB22
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- POWERS, W.T. EB22
The OPAD Programs: Instrumenting the Investigation. For presentation at the Health Monitoring Technology Conference for Space Propulsion Systems, Cincinnati, OH, November 14-15, 1989.
- PRESTWICH, A.H. ES65
JOY, M.
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- PRESTWICH, A.H. ES65
JOSEPH, R.D.
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- PRICE, M.W. ES75
ANDREWS, R.N.
SU, C.-H.
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SZOFRAN, F.R.
The Effect of a Transverse Magnetic Field on the Directional Solidification of CdTe. For presentation at ACCG-8 Conference, Vail, CO, July 15-20, 1990.
- PRIEST, C.C. PT01
SUMRALL, P.
WOODCOCK, G. Boeing
Mars Transportation System Options and Issues. For presentation at the AIAA Space Programs and Technical Conference, Huntsville, AL, September 25-27, 1990.

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- PRIEST, C.C. PT01
WOODCOCK, G.
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- PRINCE, A.S. Thiokol
BUNKER, R.C. Thiokol
LAWRENCE, T. EH34
Effects of Moisture on Thermostructural Testing of Carbon Phenolic. For presentation at the 1989 JANNAF RNTS Meeting, Silver Spring, MD, October 17-19, 1989.
- PRZEKWAS, A.J.
CHUECH, S.G.
GROSS, K.W. EP55
Progress in Numerical Modeling of Primary Atomization in Liquid Jets. For presentation at the Institute for Liquid Atomization and Spray Systems North and South America, ILASS American 90, Hartford, CT, May 21-23, 1990.
- PUSEY, M.L. ES76
Protein Crystal Growth Research at NASA/MSFC. For presentation at COSPAR, The Hague, The Netherlands, June 25-July 6, 1990.
- PUSEY, M.L. ES76
MUNSON, S.
A Micro Apparatus for Rapidly Determining Protein Crystalline-Soluble Phase Equilibrium Concentrations. For publication in the Journal of Analytical Chemistry, San Diego, CA.
- RAMACHANDRAN, N. USRA/ES42
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- RAMSEY, B.D. ES65
BOWER, C.R.
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WEISSKOPF, M.C.
The Background Spectrum in a Fluorescence-Grated Imaging Proportional Counter. For presentation at SPIE-EUV, X-Ray, and Gamma-Ray Instrumentation for Astronomy and Atomic Physics II, San Diego, CA, July 8-13, 1990.
- RAMSEY, B.D. ES65
BOWER, C.R.
DIETZ, K.
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An Analysis of the Background in a Fluorescent-Grated Proportional Counter. For presentation at The Second London Conference on Position-Sensitive Detectors, London, UK, September 4-7, 1990.
- RAO, D.K. ES63
DILL, J.F.
DECHER, R.
PETERS, P.N.
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- RANDOLPH, J.L. TA51
SHEPARD, K.E. Lockheed
Enhancing Orbital Servicing Operations Providing Positive and Effective Management of Spare and Installed Hardware, a Case Study of the Hubble Space Telescope. For publication in the Proceedings of the Third Space Logistics Symposium, Colorado Springs, CO, April 30-May 1, 1990.
- RATHZ, T. ES75
ROBINSON, M.
HOFMEISTER, W.
BAYUZICK, R.
The Status of the MSFC Microgravity and Containerless Materials Processing Drop Tube Facility. For publication in the Review of Scientific Instruments, New York, NY.
- REASONER, D.L. ES53
Rapid Thermalization of Pickup Ions Created in the Shuttle Orbiter Outgassing Cloud. For publication in the Journal of Geophysical Research, Washington, DC.
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Rapid Thermalization of Pickup Ions Created in

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- REASONER, D.L. ES53
The CRRES Chemical Release Program – An Overview. For presentation at the 1990 Fall Meeting American Geophysical Union, San Francisco, CA, December 3–7, 1990.
- REDUS, J.R. EP51
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- REYNOLDS, N.D. ES42
Storm Tracks in a Linear Two-Layer Model With Topography. For publication in the Journal of Atmospheric Sciences, New York, NY.
- REYNOLDS, N.D. ES42
A Note on Linear Baroclinic and Orographic Instability. For publication in the Journal of Atmospheric Sciences, New York, NY.
- REYNOLDS, N.D. ES42
On the Interannual Variability of Ozone Zonal Index Cycle Vacillations for the Years 1981–1987. For publication in Preprint Volume, Special Session on Climate Variations and Hydrology/Climate Variations, Anaheim, CA.
- RICHMAN, M.W. ES42
OYEDIRAN, A.A.
Grain Size Reduction in Granular Flows of Spheres: The Effects of Critical Impact Energy. For publication in the Journal of Applied Mechanics, New York, NY.
- RICHMOND, R.J. ER21
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- RIDGEWAY, S.E. ES63
JEWITT, D.
CAMPINS, H.
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JOY, M.
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TELESCO, C.
An Albedo Map of Comet Brorsen-Metcalf. For publication in the proceedings to the Astrophysics and Infrared Arrays Conference, Tucson, AZ, February 1990.
- ROBERTS, B. ED62
CARRASQUILLO, R.
DUBIEL, M.
OGLE, K.
PERRY, J.
WHITLEY, K.
Phase III Simplified Integrated Test Results. For presentation at the 20th International Conference on Environmental Systems, Williamsburg, VA, July 9–12, 1990.
- ROBERTSON, F.R. ES42
PERKEY, D.J.
Numerical Simulation of Cloud and Precipitation Structure During ERICA: Comparison With Passive Microwave Measurements. For presentation at the Fourth Conference on Mesoscale Processes, Boulder, CO, June 25–30, 1990.
- ROBERTSON, F.R. ES42
Diagnostic Assimilation of SSM/I Data Into a Global Model. For presentation at the Fifth Conference on Satellite Meteorology and Oceanography, London, England, September 3–7, 1990.
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CFD Simulation of Liquid Oxygen in a SSME Preburner Injector Element. For presentation at

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RODGERS, E.B. EH32

HUFF, T.L.

OBENHUBER, D.C.

Microbial Contamination of the Environmental Control and Life Support System for Space Station. For presentation at the Microcontamination '90 Conference, Santa Clara, CA, October 30–November 2, 1990.

ROTHERMEL, J. ES43

JONES, W.D.

HAMPTON, D.

SRIVASTAVA, V.

JARZEMBSKI, M.

Airborne Coherent Continuous Wave CO₂ Doppler Lidars for Aerosol Backscatter Measurement. For presentation at the Fourth Airborne Geoscience Workshop, LaJolla, CA, January 20–February 1, 1991.

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BOWDLE, D.A.

VAUGHAN, J.M.

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HAMPTON, D.

Aerosol Backscatter Measurements at 9.1 and 10.6 Microns Over Remote Pacific Using Focused Coherent Doppler Lidar. For presentation at the Fall 1990 AGU Meeting, San Francisco, CA, December 3–7, 1990.

RUPP, C.C. PS04

Small Expendable Deployer System Deployer Flight Data Format. For presentation at the Fourth International Conference on Tethers in Space, Florence, Italy, September 30–October 5, 1990.

RYAN, R.S. ED01

Lessons Learned in Engineering. For presentation at the Pressure Vessel and Piping Conference, Nashville, TN, June 18–21, 1990.

SAFIE, F.M. CT13

HAGE, R.T.

A Simulation Model for Risk Assessment of Turbine Wheels. For presentation at the Annual Reliability and Maintainability Symposium, Orlando, FL, January 29–31, 1991.

SAFIE, F.M. CT13

A Statistical Approach for Risk Management of Space Shuttle Main Engine Components. For presentation at the Probabilistic Safety Assessment and Management Conference, 1991, Beverly Hills, CA, February 4–7, 1991.

SAKURAI, H. ES65

NIIZEKI, H.

NOMA, M.

A Hard X-Ray Polarimeter Utilizing Compton Scattering. For publication in SPIE – The International Society of Optical Engineering, Bellingham, WA.

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- SCHMIDT, G.R. EP53 tion at the 27th Space Congress, Cocoa Beach,
VAUGHN, D. MMC FL, April 24-27, 1990.
- Analytical Modeling of No-Vent Fill Process.
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- SCHMIDT, G.R. EP53
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Conceptual Design of Subscale Orbital Fluid
Transfer Experiment (SOFTE). For presentation
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Propulsion Conference, Orlando, FL, July
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- SCHONBERG, W.P. EH15
DARZI, K.
Effect of Projectile Shape and Material on the
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Multiwall Structures. For publication in the In-
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- SCHUBERT, G. ES44
WALTERSCHEID, R.L.
HICKEY, M.
Gravity Wave-Driven Fluctuations in the OH
Nightglow From an Extended, Dissipative
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of Geophysical Research, Washington, DC.
- SCHUTZENHOFER, L.A. ED32
McCONNAUGHEY, H.V.
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Perspective. For presentation at the AIAA
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Los Angeles, CA, February 13-15, 1990.
- SCHWINGHAMER, R.J. ES01
Productivity-TQM's Alter Ego. For presenta-
- SEAFORD, M. ED33
SALADINO, A.
PRAHARAJ, S.
Upgrade of PARC2D to Include Real Gas
Effects. For presentation at the AIAA 28th
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8-11, 1990.
- SEAFORD, M. ED33
LIVER, P.
PRAHARAJ, S.
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Science Meeting, Reno, NV, January 8-11,
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- SHEALY, D.L. ES52
HOOVER, R.B.
Design and Analysis of Aspherical Multilayer
Imaging X-Ray Microscopes. For presentation
at SPIE's International Symposium on Optical
and Optoelectronic Applied Science and En-
gineering, San Diego, CA, July 8-13, 1990.
- SHELTON, B.W. PD01
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Space Congress, Cocoa Beach, FL, April
24-27, 1990.
- SHINAGAWA, H. ES53
The Evolution of Magnetic Flux Ropes in the
Lower Ionosphere of Venus. For presentation at
the 1989 Fall AGU Meeting, San Francisco,
CA, December 4-8, 1989.
- SHINAGAWA, H. ES53
KIM, J.
NAGY, A.F.
CRAVENS, T.E.
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| SILVER, E. | ES65 | SPENCER, R.W. | ES43 |
| HOLLEY, J. | | CHRISTY, J.R. | |
| ZIOCK, K. | | GRODY, N.C. | |
| NOVICK, R. | | Global Atmospheric Temperature Monitoring With Satellite Microwave Measurements: Methods and Results 1979-1985. For publication in AMS Journal of Climate, Boston, MA. | |
| KAARET, P. | | | |
| WEISSKOPF, M. | | | |
| ELSNER, R. | | | |
| BEEMAN, J. | | | |
| Bragg Crystal Polarimeters. For publication in the Journal of Optical Engineering, Bellingham, WA. | | SPENCER, R.W. | ES43 |
| | | CHRISTY, J.R. | |
| | | Global Atmospheric Temperature Anomaly Monitoring With Passive Microwave Radiometers. For presentation at the AMS Special Session on Climate Variations and Joint Session on Hydrology/Climate Variations, Anaheim, CA, February 7-9, 1990. | |
| SMITH, R.E. | FWG | | |
| ANDERSON, B.J. | ES44 | | |
| CATLETT, K. | FWG | | |
| Marshall Engineering Thermosphere Model Statistical Analysis Mode. For presentation at the 29th Aerospace Sciences Meeting, Reno, NV, January 7-10, 1991. | | SPRINGER, W.T. | ET53 |
| | | COLEMAN, A.D. | |
| | | DRISKILL, T.C. | |
| | | Vibration of a Damaged Boxbeam. For presentation at the International Model Analysis Conference, Kissimmee, FL, January 29-February 1, 1990. | |
| SNYDER, R.S. | ES76 | | |
| RHODES, P.H. | | | |
| ROBERTS, G.O. | | | |
| Electrophoresis Experiments for Space. For presentation at COSPAR, The Hague, The Netherlands, June 25-July 5, 1990. | | STONE, N.H. | ES53 |
| | | An Overview of the Scientific Capabilities of the Electrodynamic TSS. For presentation at the Fourth International Conference on Tethers in Space, Florence, Italy, October 1-5, 1990. | |
| SPENCER, R. | ES43 | | |
| CHRISTY, J. | | | |
| HOOD, R. | | | |
| Ten-Year Atmospheric Temperature Intercomparisons Between MSU Channel 2 and Radiosonde Data Over the United States. For presentation at the Fourth Conference on Satellite Meteorology and Oceanography, London, England, September 3-7, 1990. | | SU, C.-H. | ES75 |
| | | LEHOCZKY, S.L. | |
| | | SZOFRAN, F.R. | |
| | | Directional Solidification of HgCdTe and HgZnTe in a Transverse Magnetic Field. For publication in the Journal of Crystal Growth, The Netherlands. | |
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| Global Tropospheric Temperature Monitoring With Passive Microwave Radiometers. For presentation at the 14th Climate Diagnostics Workshop, LaJolla, CA, October 16-20, 1989. | | SU, C.-H. | ES75 |
| | | LEHOCZKY, S.L. | |
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| SPENCER, R.W. | ES43 | | |
| CHRISTY, J.R. | | | |
| Precise Monitoring of Global Temperature Trends From Satellites. For publication in Science, Washington, DC. | | SUESS, S.T. | ES52 |
| | | McINTOSH, P.S. | |
| | | MAI, J. | |

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Rotation of Solar Features in H-Alpha. For presentation at the 175th Meeting of the American Astronomical Society, Albuquerque, NM, June 10-14, 1990.

Convective Effects in the Compositional Redistribution During Solidification of HgZnTe and Related Materials. For presentation at the Eighth American Conference on Crystal Growth, Vail, CO, July 15-20, 1990.

SULLIVAN, R.M. ED24

SALAMON, N.J.

A Theoretical Formulation of a Finite Element to Model the Thermomechanical Behavior of Charring Carbon-Phenolic Insulators. For presentation at the JANNAF Rocket Nozzle Technology Subcommittee Meeting, White Oak, MD, October 17-19, 1989.

SZOFRAN, F.R. ES75

PERRY, G.L.

LEHOCZKY, S.L.

Automated Compositional Mapping of Narrow Bandgap Alloy Semiconductors. For presentation at the Gordon Research Conference, Oxnard, CA, March 12-16, 1990.

SUSKO, M. ES44

Space Shuttle's Externally-Induced Environment (Rocket Exhaust) Compared With Skylab's Natural Environment (Micrometeoroids). For presentation at the Fifth Annual Technical and Business Exhibition and Symposium (TABES), Huntsville, AL, May 16-17, 1989.

TAYLOR, K.R. PS05

Space Station Payload Adaptation System. For presentation at the 27th Space Congress, Canaveral Council of Technical Societies, Cocoa Beach, FL, April 23-27, 1990.

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TORR, D.G.

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DOUGANI, H.

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A Procedure for the Extraction of Weak Spectral Features in the Presence of Strong Background Radiation. For publication in the Journal of Geophysical Research, New York, NY.

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JOY, M.

DIETZ, K.

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COBB, S.D.

LEHOCZKY, S.L.

TELESCO, C.M. ES63

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- TEPOOL, R.E. EP71
Marshall Space Flight Center Test Facilities. For presentation at the AIAA Conference, Huntsville, AL, September 25-27, 1990.
- THOMAS, F. ED52
FINCKENOR, J.
Mechanical Joints and Large Components for Pathfinder In-Space Assembly and Construction. For presentation at the AIAA 31st Structural Dynamics and Materials Conference, Long Beach, CA, April 2-4, 1990.
- TINKER, M.L. ED22
CLAYTON, J.P.
Structural Properties of Advanced Fabric for Deployable Aerobrakes. For presentation at the 41st IAF Congress, Dresden, German Democratic Republic, October 6-13, 1990.
- TINKER, M.L. ED22
Damping Phenomena in a Wire Rope Vibration Isolation System. For presentation at the International Congress on Recent Developments in Air and Structure Borne Sound and Vibration, Auburn, AL, March 8, 1990.
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MOWERY, D.K.
Tether Satellite System Dynamics and Control. For presentation at the Fourth International Conference on Tethers in Space, Florence, Italy, October 1-5, 1990.
- TORR, D.G. ES51
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Compiled by Joyce E. Turner

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.



C.D. BEAN
Director, Administrative Operations Office



